A simple method for quantifying effects of management practices on cracking clays under dryland conditions

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Abstract

Structural differences in cracking clays are easy to visually assess, but difficult to quantify. Measuring soil strength with a cone penetrometer is a useful method of quantifying structural differences when the soils have been subjected to different management practices. Irrigation of small (5m x 5m) areas to a point at or near the soil's upper drained limit provided a cheap and useful method of comparing soil physical characteristics using a cone penetrometer. Differences between soil management treatments in cone penetration resistances, which were not apparent over a range of moisture, became apparent when the soils were brought to similar moisture content. The destructive nature of constructing irrigated areas makes this technique unsuitable for small plot experiments but very useful for comparing large plot or paddock scale experiments.

Key Words

Vertisols, cracking clays, soil structure.

Introduction

Cracking clays or Vertisols (1) cover an area of 48 million hectares in Australia, much of this in low rainfall areas (2). These soils are important in the marginal cropping areas of northern New South Wales and Southern Queensland because of their high water holding capacities and the frequency of their occurrence. Structural degradation of these soils is easy to identify through visual assessment, but hard to quantify through traditional soil physical measurement techniques such as cone penetrometer resistance. This is because they swell and shrink and soil strength changes with moisture content. Soil moisture content has a much greater effect on soil strength than the treatment differences (3). Problems occur when different treatments in an experiment are compared at the same time but at different moisture contents.

Materials and Methods

Adjacent paddocks of traditionally cultivated wheat and native pasture were selected on a grey clay and a brown clay in the Walgett district of NSW. The cropping paddock on the grey clay site had been cropped for 22 years and the brown clay site for 12 years. Previous attempts to determine physical differences between treatments using a cone penetrometer had failed, even when taking moisture into account.

Two small (5m x 5m) areas in each treatment were bunded to a height of 0.3m using a small three point linkage grader blade and tractor. These areas were irrigated to a point at, or near upper drained limit (UDL) by flooding the areas and allowing the soil to equilibrate over a period of several weeks. It was necessary to wait until a significant rainfall event (>50mm) occurred until the bunded areas could be successfully flooded. Builder’s plastic was placed over the irrigated areas to minimise evaporation losses and to prevent weeds from growing.

Soil strength was measured using a Rimik™ CP10 penetrometer to a depth of 0.45m. Corresponding soil samples were taken and gravimetric moisture content was determined to see if differences in soil strength were due to differences in soil moisture.

Results

There were no differences in soil moisture between crop and pasture treatments for the brown clay, but soil moisture content was higher at all depths for the pasture treatment in the grey clay. Soil strength was significantly higher for the crop treatment between 0 and 0.35m in the

grey clay and between 0.15 and 0.25m in the brown clay (Figure 1)

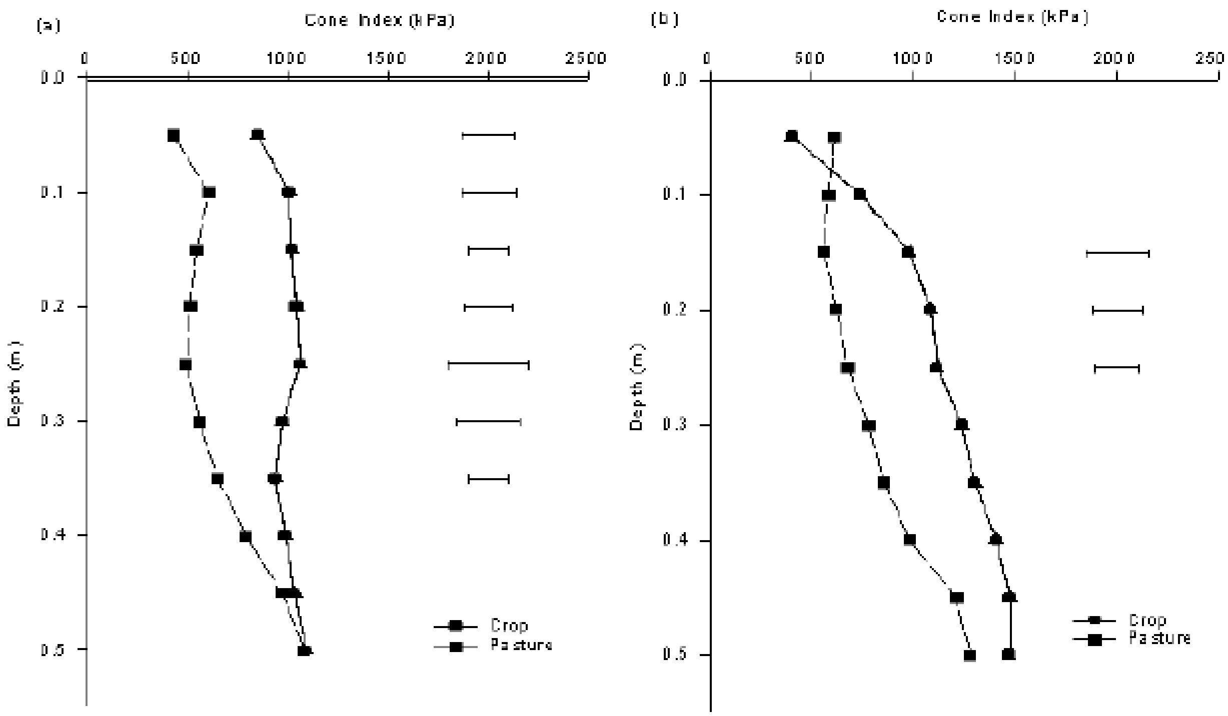

Figure 1. Cone penetrometer resistance for crop and pasture treatments at upper drained limit (a) in a grey clay and (b) in a brown clay. Error bars represent LSD (95%) and are only shown where differences exist.

Discussion

In cracking clays, soil strength increases with decreasing moisture content. Using a cone penetrometer in these soils is difficult because the relationship between soil strength and soil moisture content is confounded at low moisture contents by the penetrometer hitting cracks and recording very low soil strength values. Bringing soil moisture to the upper drained limit allows different management treatments to be compared after the soil has been subjected to the same moisture regime.

Many of these soils are located in the drier areas of Australia where annual rainfall is low and variable. Obtaining samples over a range of moisture conditions in the field may take a long time because of the unpredictable nature of this rainfall. The same soil under different management treatments may have different moisture contents between treatments because of differences in infiltration rates. Irrigation of these soils to moisture contents above the residual shrinkage phase eliminates the differences in soil physical properties due to shrinkage and reduces differences due to soil moisture.

Obtaining soil physical measurements to quantify differences between management treatments are usually destructive and require relatively large areas for measurement. Laboratory methods are often unsatisfactory because of the large number and size of samples required. Irrigation of small areas in these soils provided a cheap and useful method of comparing soil physical characteristics using a cone penetrometer in the field. The destructive nature of grading these areas makes this technique unsuitable for small plot experiments but very useful for large plot or paddock scale treatments.

References

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